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Beta Carotene Supplementation

Last month I proposed a new look at an old product and will continue that theme this month. Beta Carotene has been produced in plant tissues ever since plants have been growing. Beta Carotene is a natural carotenoid in fresh forage and is the primary Vitamin A precursor. Vitamin A is required for eyesight, growth, reproduction and in the maintenance of epithelial tissues. When the animal consumes beta-carotene, it is converted to retinol in intestinal cells then the retinol is converted to Vitamin A in the liver. There are several manufactured forms of Vitamin A, which are esterified forms of retinol. Some common examples are: retinyl palmitate, retinyl proprionate and retinyl acetate. Beta Carotene is available in plants that are actively growing and green but levels decline with maturity and exposure to sunlight during the harvesting process. Common deficiencies can be abortions, retained placenta, reduced immune function and calf morbidity. Beta Carotene supplementation has been shown to have positive effects for reproduction, immunity and milk production in dairy cows.

Beta-Carotene levels can be determined by a blood test that is available and can be conducted on site at a dairy. The recommended beta-carotene level in dairy cows is 3.0 micrograms/ml. I reviewed several research publications for this article, which revealed many of the dairy herds sampled throughout the U.S. are deficient in beta carotene with variations in blood concentrations geographically. Obviously pasture based systems were higher than confinement dairies but both were routinely below the 3.0 threshold.

Beta-carotene functions separately from Vitamin A and plays a key role as an anti-oxidant. Anti oxidants are essential to remove free radicals from the blood stream during times of oxidative stress. Transition cows are routinely under oxidative stress during early lactation due to a negative energy balance. If anti oxidants are limited during this time, the result will be oxidative stress and cell damage. The dairy will see this reflected in retained placentas, udder edema and mastitis. One study reported that cows that were supplemented with 300 mg of beta-carotene per day had lower somatic cell counts and fewer clinical mastitis diagnoses when compared to controls that were not supplemented. Beta-carotene has also been shown to have an antioxidative effect inside the rumen. Supplemental beta-carotene in the presence of safflower oil resulted in increased growth of rumen bacteria and increased fiber digestion. If free radical production overpowers the antioxidant ability of the animal, then immune deficiency responses will be realized in the dairy cow that will limit production. If dairy cows are below the 3.0 microgram per milliliter, then supplemental beta-carotene may be beneficial to improve immune response.

Studies that examined beta-carotene on milk production have yielded mixed results. Supplementation appears to have more effect when animals are exposed to environmental or pathological stressors. One study reported an 11% increase in milk production in cows supplemented with 400 mg/d beta-carotene compared to controls. The cows were under significant heat stress as the experiment was conducted in the southern United States. A study with cows supplemented 90d pre-

partum reported an 8% increase in milk production and decreased somatic cell counts during the first 60 days of lactation. The controls in the same study had elevated SCC levels during the experiment. One study examined a group of dairy cows to evaluate beta-carotene status. All cows were found to be deficient and half were supplemented to achieve a 3.0 microgram/ml level in serum. The cows were then monitored for production characteristics. The supplemented cows yielded slightly more milk but significantly more milk fat. In spite of conflicting results on increased production, there is certainly no indication that supplemental beta carotene had a negative impact on production but could be a tool to be used during times of stress whether biological or environmental for increased immune response.

Reproduction is extremely important on every dairy. Supplemental beta-carotene has been shown to increase reproductive performance through improved ovarian function. There are two primary structures on the ovary that drive reproduction, the follicle and the corpus luteum. The follicle has been shown to require circulating beta-carotene to fuel the granulosa cells in the follicle, which produce estrogen. Increasing levels of estrogen is what cause standing estrus and subsequent ovulation. The follicle must have adequate beta-carotene in order to manufacture estrogen in the granulosa cells. If estrogen is limited, then the cow will not ovulate which can result in cystic follicles. Beta Carotene supplementation has been shown to decrease the incidence of follicular cysts in dairy cows. If the cow does not ovulate, she will not get pregnant. The corpus luteum is a structure that forms on the ovary after ovulation, and is the result of remodeling of the follicle that produced the egg to be fertilized. The corpus luteum produces progesterone, which is the hormone of pregnancy. If progesterone levels are not adequate, then the pregnancy will not be maintained. Low progesterone levels during early pregnancy have been shown to be a primary cause of early embryonic loss in dairy cows. The corpus luteum has been shown to have a minimum requirement for beta-carotene in order to produce adequate levels of progesterone. If beta-carotene levels are not adequate, then corpus luteum function will be limited and progesterone will not be produced. Studies examining beta carotene supplementation on pregnancy rates in dairy cows have shown that supplemented cows get pregnant sooner and have less embryonic loss than non supplemented cows.

Most of the research regarding beta-carotene is 20+ years old and likely deserves a new look. Beta-carotene is another old product that can impact the production, immunity, and reproduction in dairy cows.